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A Band II ferrite aerial unit for portable receivers

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Summary

The whip aerial needed for good reception at v.h.f. is a drawback to the use of portable sound receivers. A small v.h.f. aerial unit has been built using a recently developed ferrite rod which is commercially available at low cost. The unit has been incorporated inside the cabinet of a simple v.h.f. domestic portable receiver. It provides adequate signal pick-up and has the advantage of being less disturbed by the movement of people near the receiver.

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1. Introduction

Present-day portable v.h.f. radio receivers are fitted with telescopic whip aerials. These aerials can be very inconvenient in use and compare very unfavourably in convenience with the built-in ferrite rod aerials for l.f. and m.f. The whip aerial must be extended and, for stable reception, often has to be positioned for maximum signal each time the set is moved to a new location. It tends to be affected by hand capacitance and the proximity of conducting objects, so that an optimum position is not rapidly found. Moving the receiver with the aerial extended can also prove hazardous.

Recently attention has been drawn to the availability of a ferrite rod which has both useful permeability and low loss at v.h.f.* Its properties as a ferrite aerial have been investigated and an inexpensive portable receiver has been modified to operate with such an aerial. Generally the performance, in terms of sensitivity, with either the whip or the ferrite aerial has proved to be approximately equal.

2. The ferrite-rod aerial unit

The rod employed is a Nickel-Zinc ferrite rod manufactured by Neosid Limited under the code number F29, which is 123 mm long by 8 mm diameter. The initial permeability of the material is 12 and it has a loss angle of 0·0025 at 100 MHz.

The arrangement of the aerial circuit is similar to that used for ferrite rod aerials in m.f. receivers. A tuned coil of three turns and a coupling coil of two turns are wound on the rod. Variable tuning is provided by means of a varicap diode. A f.e.t. pre-amplifier buffer stage is inserted between the coupling coil and the receiver input. The circuit diagram is shown in Fig. 1.

3. Incorporation in the receiver

The aerial unit has been substituted for the whip aerial in a small domestic portable receiver. The receiver tuning is performed with a mechanically variable capacitor that is unsuited for direct coupling to the aerial unit tuning control. For experimental purposes a separate potentiometer control has therefore been used for this purpose; a meter, indicating the receiver a.g.c. level, has also been added so that the user can tune the aerial unit for maximum signal and correct r.f. alignment. In a properly designed receiver the use of varicap diodes for all circuits can provide ganged tuning in a simple way, and no tuning complication arises. At present all v.h.f. transmitters radiate a horizontal electric field component; although it may be weaker than the vertical field component near the ground for the few stations which radiate a vertical component additionally (slant, circular or mixed polarizations), the horizontal field component is always present. The ferrite rod has therefore been set with its axis vertical to give maximum signal pick up for horizontally polarized signals. The arrangement of the aerial unit mounted in the receiver is shown in Fig. 2.

4. Design considerations

As the permeability of the ferrite rod is relatively low, the prime consideration for the aerial circuit design is maximum sensitivity. This is achieved by matching the transferred input resistance of the f.e.t. amplifier to the tuned circuit loss resistance. The signal developed at the input gate of the f.e.t. amplifier is then independent of the number of turns wound on the rod.

The choice of tuned circuit inductance was largely dependent on the capacitance range of the varicap diode when operated from the receiver battery supply (6V). Three turns of enammelled 26 s.w.g. wire wound on the rod give an inductance of 0·35 μH with a circuit magnification factor, Q of 195 measured at 50 MHz. The tuned-circuit Q is also dependent on the capacitor losses. The maximum series loss resistance for the varicap diode, is quoted by the manufacturers as 0·8Ω; this gives an unloaded Q of 110 for the combination of these components. The effective Q under matched conditions is half of this value. In the above considerations the radiation resistance of 0·0016 ohms has been neglected since it is so small compared with the circuit loss resistance. The input admittance of the f.e.t. amplifier is approximately (0·3 + j3·5) mS. The mutual inductance between the tuned and coupling coils on the ferrite rod, required to match the resistive component of the primary and secondary circuits is 0·12 μH. A coupling coil of two turns has been used and the separation between the two coils has been adjusted to achieve this. Initial adjustments were made using an inductance bridge but the final adjustments were made on the assembled unit to give maximum sensitivity.

A simple circuit is used to transform the receiver input impedance to a suitable load value for the f.e.t. amplifier. The measured voltage gain of the amplifier when terminated in a 50Ω load is 5 dB.

The calculated ratio between the ferrite rod unit output and that of a $\lambda/2$ dipole is −11 dB. Little improvement can be made to the sensitivity of the ferrite unit by increasing the length/diameter ratio of the rod itself or by increasing the number of turns would on the rod.

5. Performance of the receiver

An idea of the receiver performance with the ferrite rod unit can be obtained from Fig. 3. This shows the measured signal-to-noise ratio with the receiver placed in a known field strength. (The measurements were unweighted in the band 0 – 15 kHz when the reference signal was a 400 Hz tone at 22·5 kHz peak deviation.)

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* The possible use of such rods in v.h.f. portables was suggested by Mr. P.A. Tingey of BBC Designs Department.

The performance at low signal strengths is limited by the noise generated in the tuned circuit loss resistance. With a tuned circuit Q of 110 the Johnson noise voltage is equal to the available signal when the field strength is 20 µV/m. The performance of the receiver with the ferrite rod aerial was similar to that when used with its own whip aerial. This may seem somewhat surprising in view of the estimated ratio between the output of the ferrite unit and a λ/2 dipole output, but it can probably be attributed to the fact that the whip aerial will not be very efficient when untuned, using a small chassis as a counterpoise.

6. Conclusions

A v.h.f. portable receiver has been adapted to operate with a ferrite rod aerial, and has given a satisfactory performance during trials. The performance at low signal strengths is limited by the tuned circuit losses but it is possible for improvement to be made here.

Future development would be necessary to incorporate a simple control, tuning both aerial unit and the receiver together. For receivers using varicap diode tuning throughout this should not be unduly difficult.

Although the main reason for this work has been to eliminate the whip aerial from the receiver, it is possible that it should be retained and positioned in the receiver near the ferrite rod, so that under difficult reception conditions it can be extended to enhance the signal induced in the ferrite rod.

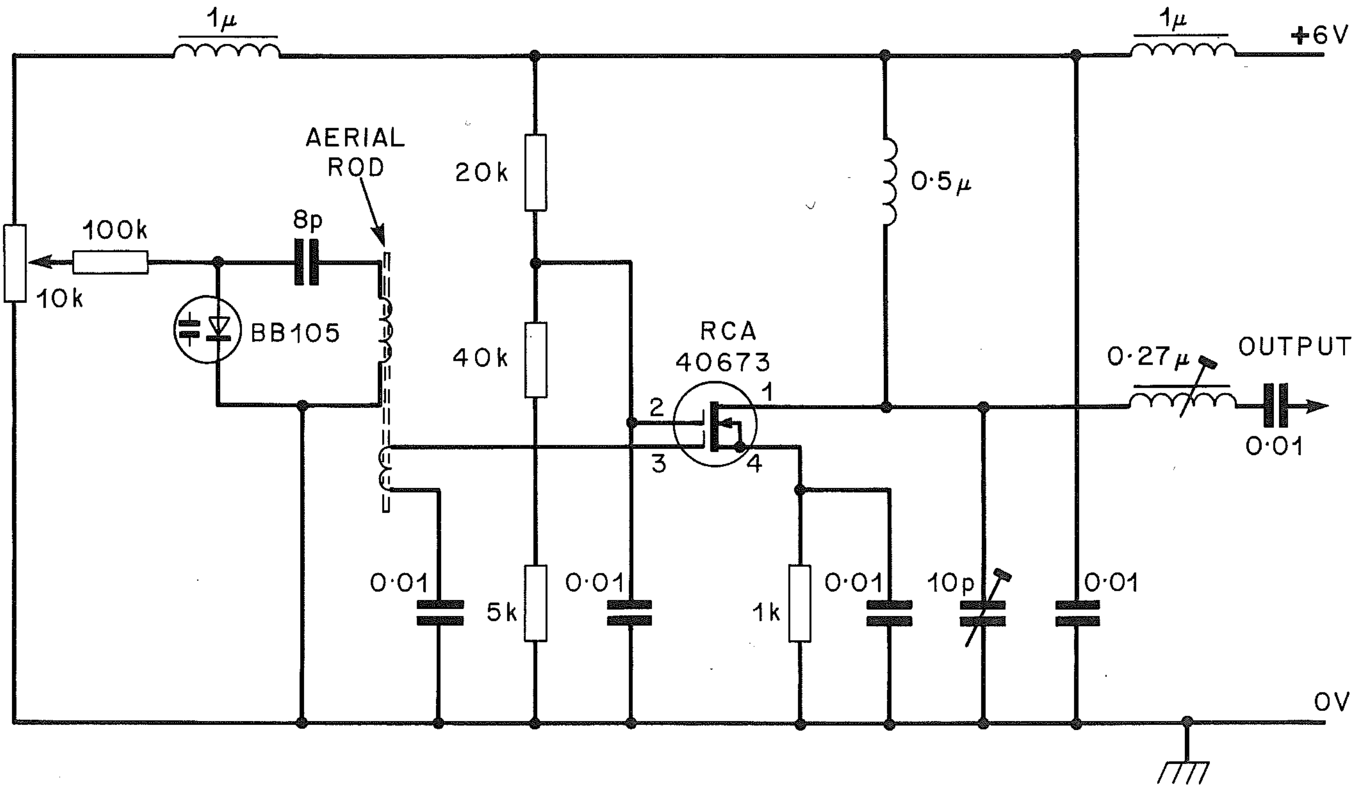

Fig. 1 - Circuit diagram of ferrite aerial unit

SMW/DS

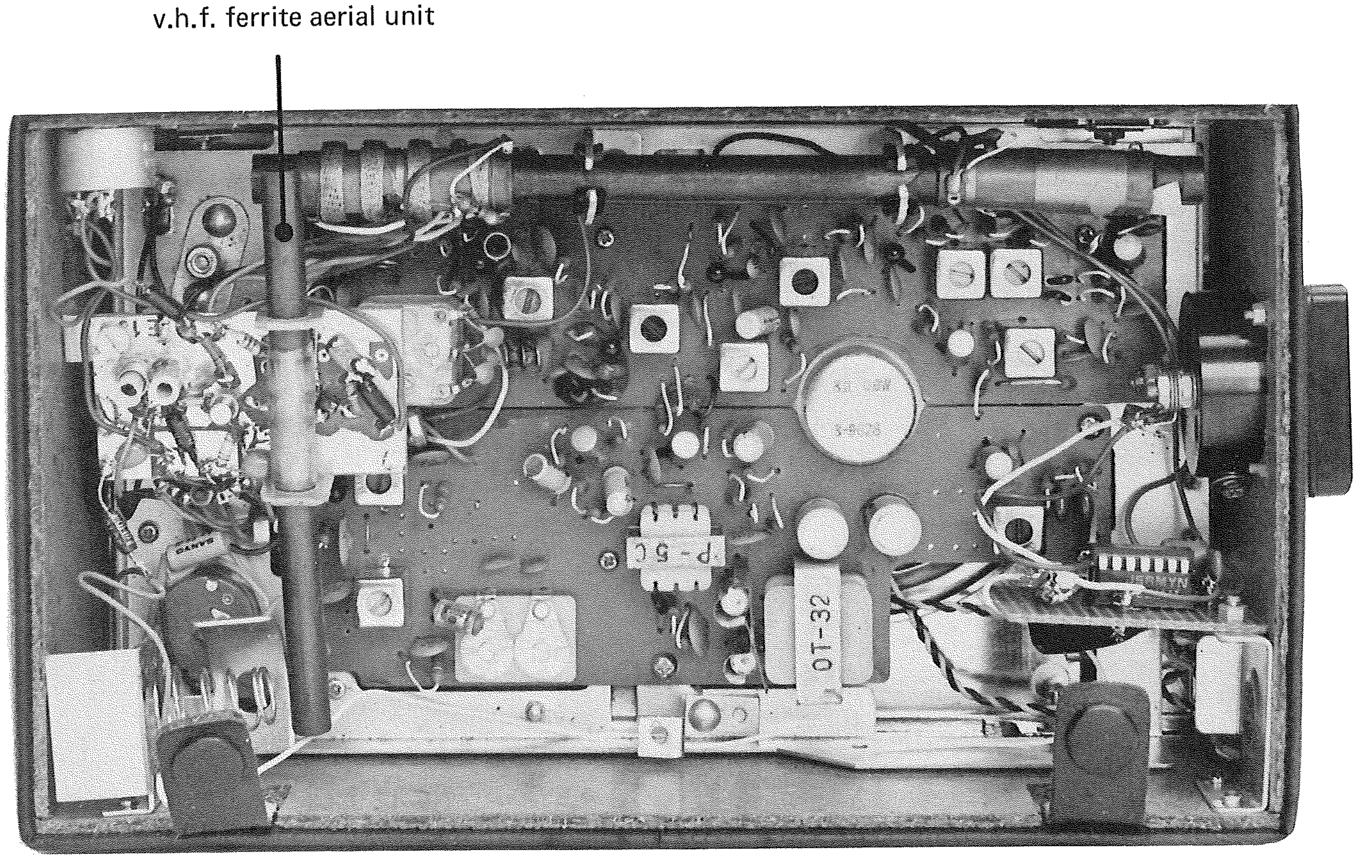

Fig. 2 - Ferrite aerial unit fitted into receiver

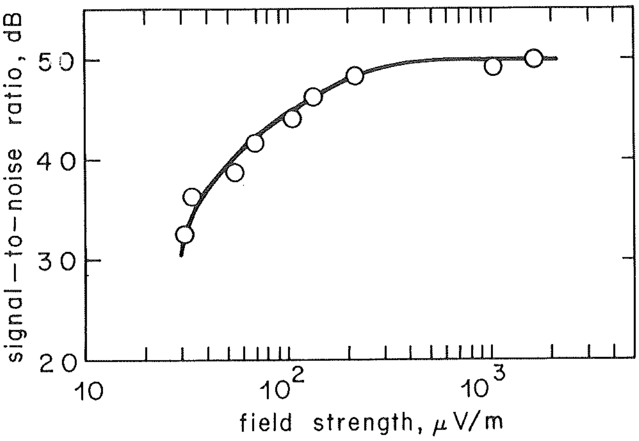

Fig. 3 - Receiver signal-to-noise output versus field strength level